Putting knowledge into practice

Universiti Putra Malaysia is working with industry to ensure its aerospace engineering students become more experienced, from designing aircraft to flight testing.

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FLYING at 1,500 feet above ground in a single-engine, four-seat aircraft while experiencing potential flight scenarios, was the most nerve wrecking 60 minutes of Tan Yin Yaw's life.

Tan and two other coursemates from Universiti Putra Malaysia's (UPM) Aerospace Engineering course, boarded a Cessna 172 flown by experienced pilots.

The three were selected from a total of 40 students in the course, through a lucky draw.

Minutes after taking off, the final year students experienced positive and negative gravity forces as the pilots quickly descended the aircraft, before deploying the flaps, causing the aircraft to rise upwards due to the increased lift and centre of pressure movement.

This was part of the students' practical learning through a subject specifically designed for the varsity's final year Aerospace Engineering students; known as the Aviation Laboratory for Agriculture Purposes.

Simply put, students learn the flight testing of an airplane.

This is the first time the university is conducting flight testing as part of the course.

In acknowledging Higher Education Minister Datuk Seri Idris Jusoh's calls of closer collaborations between industries and the academia to create more employable graduates, UPM has collaborated with Air Adventure Flying Club for the flight testing subject.

In addition to that, the course also sees the cooperation from the Department of Civil Aviation (DCA), Airport Fire Rescue Services, Jabatan Meteorologi Selangor and Malaysia Airports Holdings Berhad.

Despite feeling edgy and high on adrenaline throughout the flight, Tan says it helped him realise that theoretical knowledge may not apply in real life.

"Observing how the pilots stalled the aircraft and performed extreme banking, left me surprised at the extent of the aircraft's capabilities.

"I also did not expect them to be that light and unstable; this method of learning will definitely help me in my studies," the 22-year-old adds.

UPM Department of Aerospace Engineering senior lecturer Dr Zairil Zaludin says the varsity's main objective is to make their students more experienced, from designing aircraft to flight testing.

Industry experts are often heard lamenting the lack of practical knowledge graduates' possess, while well versed in theory.

"We are trying to bridge this gap. This is an example of how an educational institute is working with the industry.

"The first three years of their course involves theoretical studies and laboratory work, where they learn complex yet interesting equations and formulas to understand the phenomena associated to flight and advanced aerospace technologies.

"This is necessary when designing and manufacturing aerospace products and services.

"Finally, they will have to fabricate building an airplane," Dr Zairil shares.

Therefore, he says, what was missing was an actual flight experience.

During their calculations, students imagine how an aircraft will behave on air.

However, a better approach would be to actually fly a plane and feel what it is like when a plane pitches upwards, or banks left and right, among other movements, Dr Zairil adds.

"The more a student experiences, the better they become."

For him, it is essential to have practical experience as it assists students in having more accurate and precise calculations.

However, even so, he says there will be discrepancies, especially in factors involving the weather.

The changes in weather plays an important role in the performance of an airplane and students shouldn't design one without factoring the weather in, Dr Zairil adds.

The subject is, however, not a mere joyride for students as they have to perform tasks similar to that of an aerospace engineer and flight test engineers.

"During the designing phase of the course, students will have to calculate the predicted performance of the aircraft using equations and formulas they have learned throughout the course.

"With these set of values, students will have a 'scientific educated guess' on how the aircraft will behave during the flight," he adds.

In reality, due to safety, cost and limited time, it is not feasible for students to design, build and flight test a new aircraft.

Therefore, the course instead focuses on a hypothetical situation where students 'design' a light aircraft approximately the size and shape of a Cessna 172.

"Eventually, when the aircraft is flight tested by them, they will have to obtain the real values produced by the aircraft and record the data in their logbooks.

"This makes the course exciting for these future aerospace engineers!" Dr Zairil says.

In addition to giving them a real life experience, the course also gives students a chance to correlate theory to practice.

As academicians, we hope such training would lead these future aerospace engineers to building new aircraft, and perhaps improve the local aerospace industry, he adds.

(From left) Tan , Hasnor Farah and Muhammad Fakhrul play the role of flight test engineers, as they brief Dr Zairil (right) and Walther before their flight testing. — Photos by S.S. KANESAN/The Star

Captain Payne (third from left) and Walther (right) conduct a pre-flight briefing for (first and second from left) Muhammad Fakhrul, Tan and (second from right) Hasnor Farah, as flight test engineers.

When academia and industry come together

With over 25 years of experience, Dr Zairil's passion for the field is apparent.

During a personal flight training session with Air Adventure Flying Club, the thought of collaborating with the flying school occurred to him.

Upon discussion, Dr Zairil realised the club shared the same passion as the varsity in unearthing the vision.

"All we needed to do was to tailor their training to our requirements to satisfy the needs of our programme syllabus," Dr Zairil adds.

And this was not difficult.

Back in 2009, Air Adventure Flying Club founder Captain Andreas Walther and the Club's Further Education committee member Captain Peter Jahne started a course for a private company where they incorporated aviation into learning how to deal with and solve unexpected and complex scenarios.

"During this period of time, we discovered the functions of the brain and how it reacts to behaviour.

"Therefore, when Dr Zairil proposed this project, we thought it would be great to come up with a training programme to suit UPM students where the academic and practical aspects of flying are incorporated," Walther adds.

Over the course of 14 weeks, Air Adventure Flying Club chief ground school instructor Captain Sebastian Payne brought students to the aircraft hangar and explained details of aeronautical components found on the Cessna 172 aircraft.

"Fundamental theories of aviation, including wing configurations, the effects of the controls, importance of weight distribution, engine design and safety issues were covered.

"They became fascinated and interested as I shared my experiences; helping them connect the void between the theoretical lessons learned in university and applications of that knowledge in the real world," Payne shares.

The exhilarating experience of feeling positive and negative gravity forces are related to formulas students have learnt.

Walther and Muhammad Fakhrul go through engine startup checklists to commence the flight.

"It highlights the importance of aircraft designing, allowing for sufficient structural integrity.

"Seeing and feeling the aircraft's reaction to the effects of a continuous atmospheric change is demonstrated as students fly through turbulent air.

"By climbing to higher altitudes, students witnessed the change in the engine's performance due to reduced atmospheric pressure.

"These are a few of the potential scenarios that will increase their practical knowledge and understanding of the field," he adds.

Payne says having such courses will motivate students to achieve higher standards of aerospace engineering.

In designing an aircraft, Walther says an aerospace engineer is responsible for the people it carries.

"By not assimilating with the personnel who operates an aircraft, the engineers are distancing themselves from human (emotion).

"Thus, by (working) closer, they will feel more responsible when designing as it also about taking responsibility for the consequences if a particular design fails."

He shares, during the flight testing, students' prefrontal cortex, a part of the brain located at the front of the frontal lobe, was frozen, while their amygdala, an almond-shape part of the brain that affects how people feel emotions, was reacting.

"They were sweating, panicking and had weak knees!

"The co-pilot realised his lack of knowledge and experience led him to steer away from his responsibility as he kept looking out of the window.

"Practising flight testing a few more times will allow their prefrontal cortex to (develop) and kick in, overcoming their fear that is guided by the amygdala," he adds.

He believes it is important to share knowledge with the younger generation who are in need of learning in order for them to appreciate and develop.

How the brain reacts towards unexpected flight scenarios

With some 10 years of experience in the field of aviation, with a special interest in human performance, potential and limitation, Jahne says if a person does not experiment with their senses, the brain remains rather empty.

Therefore, engaging in a flight, tests the brain structure of these young students - whether they have the capability to understand what is going on, he adds.

Jahne says, the prefrontal cortex is in charge of planning, decision making, judgement and in coordinating the brain as a whole.

"In aerospace engineering, during lessons, students use their motor sense such as when writing their reports, using their vision and audio capability.

"Their sense of smell, temperature, speed and height are not tested.

"However, for the three students who experienced flight testing, they would have observed different situations such as smelling oil, for example.

"Here, their brain alerts them of a possible leakage, and when they return to UPM to prepare a project, they will now know to include mechanisms, when designing the aircraft, that detects oil spillages based on their experience.

"The same goes with the positive and negative gravity forces they felt.

"If their brain is purely academic, they will be able to calculate formulas but they would not know what the sensations are like, and thus, may build aircrafts that cannot be flown by a pilot."

The more a student feels a sensation through reality and not through a mere simulation, they become better students as their brain has developed in a sensorial way, Jahne says.

Commending Dr Zairil for his efforts, Jahne says it is admirable how the former is educating his students by preparing them for the real world.

"These students may be able to land jobs faster than their peers as the ability to understand the sensations that comes with flying is an added value in the eyes of an employer.

"It shows they are able to design a practical airplane."

While not every aerospace engineering student may have access to flight testing, Jahne says helping out at the airport, doing manual work such as changing tyres in an aircraft and sitting in during flight training just to feel the sensations and emotions, is a good way to learn and supplement their classroom knowledge.

"A pilot has spatial awareness where they must know where they are in space and time.

"If an aerospace engineer practices this awareness when designing an aircraft, they can imagine moving the aircraft around and thus, helping them design better.

"They become creative, and not someone who merely follows a set 'recipe'.

"Resilience is key to strive in aviation and the passion comes with starting somewhere," Jahne adds.

Experiencing the real thing

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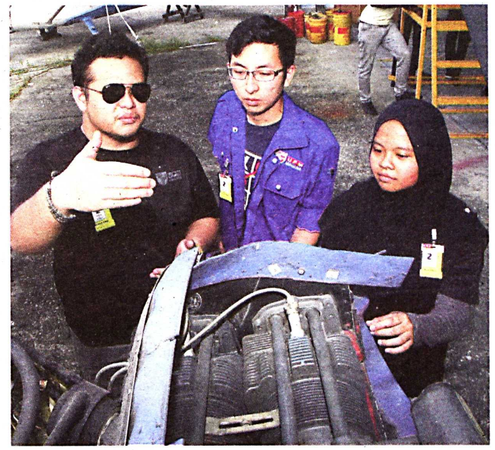

(From left) Muhammad Fakhrul, Tan and Hasnor Farah discuss the aircraft propulsion system and how data is collected from it during flight tests.

UPM students involved in the Flight Testing subject are given free membership to the Air Adventure Flying Club which grants them access to its resources such as its aircrafts and hangar, and to meet and interact with its members who are aviators.

The membership also allows students to visit sites in the Sultan Abdul Aziz Shah Airport, Subang Jaya, where permission is otherwise not granted unless one has special authorisation.

Three students who participated in the Flight Testing share their experience:

Tan Yin Yaw, 22

It was an experience of a lifetime!

My knowledge in aerospace engineering was useful when we visited sites and during the flight testing.

When Air Adventure Flying Club chief ground school instructor Captain Sebastian Payne pitched, yawned, banked and rolled the aircraft, I understood what was happening.

However, on the day of the flight testing, although I thought the weather was good to fly in, I could not have been more wrong as the ride was bumpy due to the turbulence and the wind.

These new exposures to how a flight test is, will enhance my skills as an aeronautical engineer.

We must allow ourselves to understand aircraft more than just theory, because without actually being on a lighter aircraft, an aerospace engineering student would not understand how important it is to factor in the surrounding environment such as the aircrafts stability and comfort.

If flight testing is not an option, students can work at the airport as it provides exposure.

Hasnor Farah Fatehah Hassim, 22

Applying my classroom knowledge into a real-life situation is an irreplaceable experience.

It was terrifying at first, but as the flight progressed, it got better.

I got to combine what I have learnt in the classroom with a real situation and this has enhanced my ability to understand aerospace engineering.

I am grateful to be a part of this priceless experience and I am honoured to represent UPM in this programme.

Muhammad Fakhrul Islam Madzelan, 24

For me, it was a very different experience from the theories I have learnt.

In real-life situations, you can feel the movement of the plane, unlike when you are in a simulator.

There, you are stationary all the time.

I want to become a pilot, so this was a valuable experience for me.

Although I have been warned about air pockets, I did not expect it to be this much during the flight but it was still the best kind of fun.

Hasnor Farah records flight data as the test pilot performs specific maneuvers during the flight testing.

Tan (in blue), Muhammad Fakhrul and Hasnor Farah conduct a pre-flight visualisation exercise where they go through the cockpit gauges, which reads data during flight tests.